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Mg ISOTOPIC COMPOSITION OF THE SOLAR WIND BY SIMS ANALYSIS OF GENESIS TARGETS

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Introduction: In order to deduce the isotopic compositions in the solar nebula of volatile elements, e.g., noble gases, O, and N, from analyses of the solar wind (SW), we must understand the magnitude of mass-dependent fractionation between the SW and the photosphere. With the exception of evaporation effects in CAI's, mass-dependent fractionation of Mg isotopes is small, as evidenced by Mg isotopic compositions of terrestrial igneous and meteoritic samples which agree within ~1‰ [1]. Thus, if we assume that the "terrestrial" Mg isotopic composition is also representative of the solar photosphere, we can use measurements of the SW captured by Genesis to test models of isotopic fractionation in formation of SW. For example, if the inefficient Coulomb-drag model [2] is correct, we would expect that the Mg isotopic composition in the SW is ~10‰ per amu [2] lighter than the terrestrial composition.

Experimental and Results: Fragments of a silicon target from the passive collector, a ^{25,26}Mg implant (Si target) and a terrestrial magnetite (containing low abundance of Mg-bearing inclusions) were measured in depth-profiling mode with the UCLA Cameca ims 1270. 100 × 100 μm^2 craters were sputtered with a O_2^+ beam in O_2 atmosphere (1.2E-5 torr). 7.5 keV impact energy and a field aperture of 40 × 40 μm^2 were applied to improve depth resolution. Mg isotopes and ^{28}Si were collected simultaneously on electron multipliers (Mg) and a Faraday cup (Si). A mass resolving power of 2100 sufficiently resolved ^{24}MgH from ^{25}Mg. Data are corrected for deadtime, blank and instrumental mass fractionation.

The ^{25,26}Mg implant standard was homogeneously irradiated (^{25}Mg/^{26}Mg from three areas ~5 cm apart agree within 3‰). The ^{25}Mg/^{26}Mg ratio was calibrated by solution MC-ICPMS at ASU to be 0.9571 ± 0.0051 (2σ stdev). Uncertainties in the Genesis data are ~5‰ (1σ). Due to unresolved issues with deadtime corrections, we only report δ^{26}Mg/^{25}Mg calibrated against the implant standard: 0.2 ± 4.1‰ (4 runs, 1σ stdev). This preliminary result agrees with [3, 4]. Thus, at present the isotopic fractionation in SW can neither be confirmed nor excluded. Future analyses that include more standards, a better control on the deadtime and more Genesis analyzes will reduce our uncertainties.

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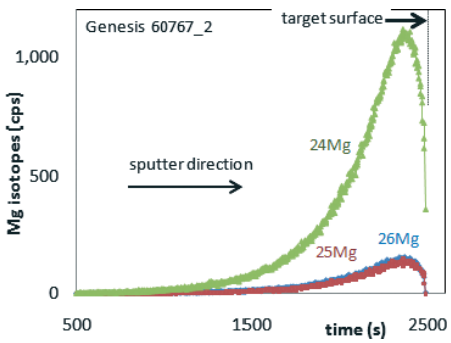

Fig. 1. Backside depth profile of SW Mg isotopes. This mode produces a complete profile, avoiding surface contamination and transient sputter effects otherwise encountered when sputtering from the front side. Isotopic ratios were calculated from the sum of the counting rates over the complete profile.

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ATOM-PROBE TOMOGRAPHY OF METEORITIC AND SYNTHETIC NANODIAMONDS

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Introduction: Because of their small size (approximately 3 nm [1]) meteoritic nanodiamonds [2] are the least understood component found in acid residue containing presolar grains. Their abundance is higher than for any other presolar grains [2], and the knowledge of their origins is therefore of great interest. Isotope anomalies in trace elements have been observed from bulk analyses of nanodiamond residue (e.g., [2]), but bulk C and N isotopic ratios are normal [3]. This and other observations have led to suggestions that only a small fraction of nanodiamonds is presolar (e.g., [4]). Another possibility is that the anomalies are carried by an associated abundant disordered non-diamond sp^2 C phase [5]. Carbon isotope analyses of individual nanodiamonds would test if ^{12}C/^{13}C ratios in any diamonds are anomalous. The atom probe tomograph (APT [6]) is currently the only instrument that can analyze the C isotopic compositions of individual nanodiamonds. The first APT results on Allende DM [7] nanodiamond residue (ADM) were recently presented [8, 9]. To correct for a potential instrumental bias, we have now prepared synthetic nanodiamond samples as analytical standards for the APT.

Methods: We used a dual-beam focused ion-beam (FIB) microscope to prepare APT samples of ADM [8]. In another approach, we deposited meteoritic or synthetic nanodiamonds directly on presharpened microtips for APT, and embedded them in a stable matrix using atomic-layer deposition [10] of W or Cu. APT analyses were performed with a Cameca LEAP4000XSi tomograph equipped with a picosecond UV laser [6].

Results: Direct deposition sample preparation eliminates the need for FIB lift-out work and improves sample stability. We succeeded in APT analyses of ADM and obtained well-defined C peaks in time-of-flight mass spectra. Our 3D-tomographic reconstructions exhibit isolated and clustered nanodiamonds. The C isotopic compositions of different APT tips of the same aliquot are identical within analytical uncertainties. At the meeting, we will present more data that will help to address the origin of the diamonds and also present APT data of synthetic nanodiamonds.

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